

PILOT REPORTED HUMAN FACTOR COCKPIT
DISCREPANCIES IN NAVAL AIRCRAFT

Gene Leroy Daniels

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THESIS

Pilot Reported Human Factor
Cockpit Discrepancies in Naval Aircraft

by

Gene Leroy Daniels

March, 1976

Thesis
Advisors:

Lewis E. Waldeisen
Douglas E. Neil

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Pilot Reported Human Factor
Cockpit Discrepancies in Naval Aircraft

by

Gene Leroy Daniels
Commander, United States Navy
B.S., Stanford University, 1960

Submitted in partial fulfillment of the
requirements for the degree of

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March, 1976

ABSTRACT

This thesis investigates the problems in current naval aircraft cockpits as perceived by fleet naval aviators who are students at the U. S. Naval Aviation Safety School. A critical incident questionnaire provides data that examines the deficiencies of an individual aircraft. These individual aircraft deficiencies are then categorized into twelve major deficiency categories which are common to more than one aircraft. Various recommendations are made concerning standards, specifications, cockpit research and cockpit design.

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I. INTRODUCTION

It must be acknowledged that the aircrewman considered as a subsystem may be the strongest and the weakest link in the overall aircraft system. It is understandable that versatile, flexible man capable of internal reprograming and learning was a strong link in the early, more simple aircraft systems. In comparison to modern aircraft, these systems were limited in such areas as speed, altitude and acceleration. Under these conditions and state of the art it was possible to put man into the system as an operator with no special consideration for his efficiency or human frailties. Even at decreased efficiency pilots were able to operate these aircraft satisfactorily; although safety experts would probably agree that this approach accounted for innumerable aircraft accidents.

At the same time, the weak link is the performance unreliability, i.e. humans cannot perform the same task in the same manner time and time again. Man also has weaknesses in psychological and physiological aspects; some of which are not at all well understood. Any part of the system which aggravates or intensifies these weaknesses ultimately will decrease the efficiency of the entire system.

While it may be argued that man slowly develops some improvement in his performance, the hardware advances in the aircraft industry have made quantum advances in the last decade or two. The hardware and system can now perform

in regions where the pilot is incapable of operating or controlling the aircraft. For instance, this point was reached some time ago in the acceleration field where aircraft became capable of sustaining four or more "G" accelerations. This resulted in the pilot's "G" suit which increased man's tolerance to acceleration stress significantly. However, present aircraft design configurations are capable of providing accelerations that again will exceed human tolerances. In the information field, comparing a World War II aircraft with a present day aircraft quickly reveals a significant increase in both quantity of data and the rate of data flow. At times, this data is well past the pilot's mental information processing capacities, hence on board computers are often included to assist in the processing of systems data and environmental information. The quantum increase in information available and the commensurate rate of flow is, in the author's opinion, certainly one of the main factors forcing the military to allocate a minimum of two crew members per aircraft. In addition, a considerable research effort has been, and is, now underway concerning the display and processing of this information in an effort to allow the human to remain an effective link in the modern airborne system.

Supplementing mission effectiveness and inexorably intertwined with overall efficiency is the safety aspect. There is little doubt that the aircrew subsystem is a weak link in this area. Depending on the criteria for accident causality, approximately 60% of naval aircraft accidents

have been attributed to the aircrew subsystem. Naturally, naval aviation is not the only organization with this problem. The army has attributed 80% of its aviation accidents to the aircrew subsystem with attendant loss of fifty-eight million dollars per year (Rickelson, Kennamore and Callen, 1975).

The point is that the aviator must be considered as a subsystem from design through planning and into operation. The aircrew subsystem performance improvement must rate the same priority as hardware if the total system performance is to be maintained or improved. One major area within the human subsystem which can be improved is the man-machine interface. That this has been at least partly recognized is shown by the increased utilization and rise in influence of the human factors engineered in the design state of aircraft cockpits.

II. PRESENT STATE

There is considerable research presently being conducted in the area of cockpit design as far as new methods of instrumentation, display and control are concerned. Skovholt, et al (1971) and Kastner and Soderquist (1964) give examples of the types of research studies and testing that appear to be pushing the state of the art in certain of the above areas. Unfortunately, however, it appears that the Navy does less than it could in coordinating and optimizing cockpit design either to remedy previous problems or to determine the best use of newly produced hardware. The Naval Air Development Center (NADC) report of 22 May 1974 is one of the first documented attempts by the Navy using its own human factors engineers to design a cockpit. The result was a mandatory specification for the lamps MK III H-2/SR helicopter which not only complies with general specifications and standards but takes into account more optimal instrument groupings and configurations using past helicopter cockpits as references. Hopefully, this will ensure that the human element in the system will be able to operate with increased efficiency.

Atkins (1969) made an effort to pinpoint the problems in U.S. Air Force aircrew station geometry. A basic premise was as follows:

"The majority of crew systems problems are induced at the initial design and development stage; consequently, the establishment of sound design philosophy supported by realistic and complete design requirements is mandatory if truly adequate crew systems are to be made the rule rather than the exception."

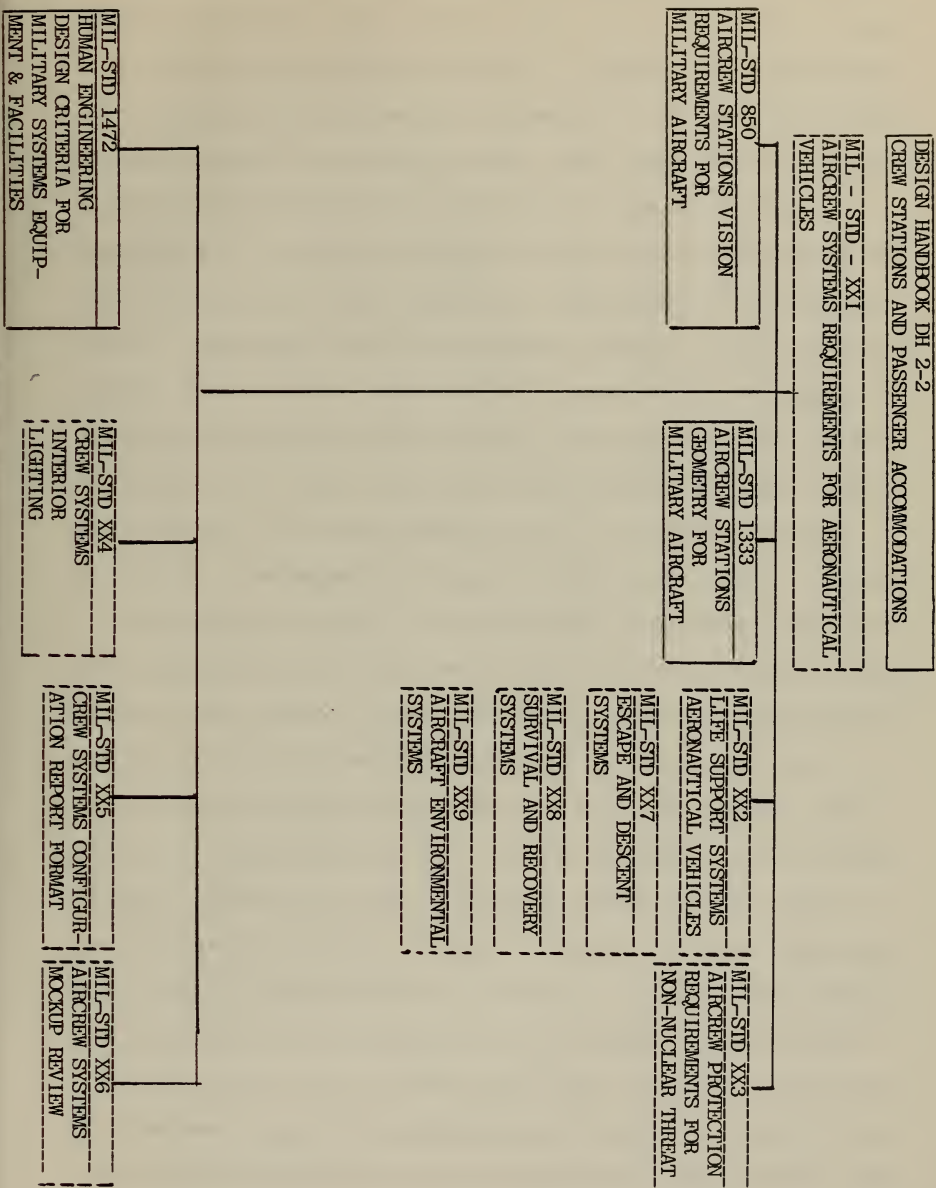
Atkins (1969) discovered very early that many of the design problems could be measured quantitatively; however, it was difficult to make definitive statements concerning standards and specifications because they were considered inadequate to define sufficient criteria for deficiency documentation. This resulted in a major effort to define standards and specifications which should be promulgated.

Nine new military standards were recommended by Atkins (1969) as shown by the documents outlined by dashed lines in Table I. It appears that four have essentially been implemented and are in use today. These four correspond to:

<u>Proposed Military Standard</u>	<u>Apparent Present Equivalent</u>
MIL-S-XX8	MIL-S-9479
	MIL-S-18471
	MIL-C-25967
MIL-S-XX9	MIL-A-23121
MIL-S-XX4	MIL-L-5667B
	MIL-L-1827C
	MIL-L-27160
MIL-S-XX6	MIL-M-8650

Presently, cockpit design in naval aircraft, except for lamps, MK III H-2/SR, appears to be left primarily to the contractor. This system relies primarily on the contractors' human factors personnel in conjunction with general specifications and standards to ensure efficient design. There seems to be little, if any, common data based on typical prevalent problems to help the contractor other than the contractors'

TABLE I



previous aircraft and experience. Certainly the Navy does commit substantial resources to improving cockpits and seems to be showing increasing interest in human factors engineering including the man-machine interface. The Navy generally becomes actively involved for the first time when a prototype cockpit is provided by the contractor or built by NADC Warminster. In neither of these places are there sufficient fleet aviators for user input nor researchers with adequate time to thoroughly check the entire cockpit. At the prototype stage a major change requires the equivalent of an Engineering Change Proposal (ECP) with all its consequential expense and delay. The Naval Air Test Center (NATC) is even further down stream in the development cycle. At NATC, a highly qualified, knowledgeable group of fleet pilots have a chance to evaluate the cockpit. Unfortunately, too often NATC test pilots must rely on a limited resource base in terms of time, aircraft and number of test pilots to determine deficiencies. Any deficiencies found must again go the expensive and time-consuming design change route. These procedures have generally caught most of the "critical" cockpit problems and "urgent" changes are made. However, every aircraft gets to the fleet with a number of known "less than urgent" problems which fleet aircrewmembers must live with. In many cases these deficiencies last throughout the life span of the aircraft. Even more distressing is the carry-over of similar deficiencies between types and generations of aircraft. There is no centralized comprehensive data bank cockpit deficiencies nor has there been any attempt to determine commonality of

deficiencies across different manufacturers and mission communities.

To obtain a broad data bank of deficiencies is not an easy task. Atkins (1969) collected information from a broad range of sources including safety and unsatisfactory reports and concluded that none were as comprehensive, easy to get or as valuable as aircrew generated data.

Atkins (1969) was the only attempt that the author was able to locate in which substantial user data was generated and used. Too often, it seems, the user of an equipment is not sufficiently utilized in determining design and efficiency requirements. Naval aircraft cockpits would seem to fall in this category. To include the user in studies, unfortunately, is very often a costly and time-consuming procedure.

In summary, this study considers the user (military aircrewmen) as an outstanding, presently untapped, source of information about deficiencies in the cockpit man-machine interface. The author claims the aircrewman is part of a subsystem in which improvements in efficiency/safety will pay large dividends in overall system improvements. To this end, answers were attempted for the following questions:

1. Does the fleet aircrewman consider that man-machine interface problems exist in naval aircraft cockpits?
2. If so, can these problems be articulated adequately for systematic study?
3. How serious are these problems?
4. Are they common among different aircraft/missions/contractors?

III. METHOD

The availability of a relatively large, professional and recently proficient group of fleet pilots from all types of aircraft and covering the entire range of mission communities is a tremendous asset. The U.S. Naval Aviation Safety School at the Naval Postgraduate School (NPGS) Monterey, California, provides this asset. Classes of from twenty to forty Naval Aviators/Naval Flight Officers (NFO) complete the safety course every six weeks. This source was used as the data base in the present study. It would, of course, be possible to get a large data base on any specific aircraft by polling pilots at a naval air station where that specific aircraft was found. The present study, however, is more interested in a broad variety of aircraft and the relationships between cockpits of many aircraft. Thus the safety school student population is not only less expensive to use, but also is optimal for variety. The only disadvantage is the relatively slow accumulation of data.

A. COLLECTION OF DATA

It was decided to employ the critical incident technique as the method to gather data from the aircrewmembers (Flanagan, 1962). This technique usually calls for determining both good and bad criteria. However, for the sake of brevity, this study gathered data only on deficiencies. It may indeed be true that an attempt to gather data necessary to

reinforce good design criteria would have as much benefit as the correction of deficiencies. However, based on the author's experience, it was felt that pilots can generally recall problems better than individual items of good design.

A four-page questionnaire was designed based on the critical incident technique using both open ended questions and a section where the problems could be categorized both by criticality and type of problem. Appendix A represents a sample of the questionnaire as given to the first two groups of subjects.

Appendix B shows the instructions which were read verbatim to the group prior to filling out the questionnaire. Each group had about forty-five minutes to complete the questionnaire.

After preliminary analysis of the first two group's data, pages three and four were deleted for reasons explained later. The third group completed only pages one and two of Appendix A.

Flanagan (1962) claimed that data collection could stop when one hundred questionnaires resulted in only two or three new items of information. Based on this criteria, there is a great amount of untapped information in this data source. This study is expected to be only a preliminary effort. Data collection is expected to continue with subsequent classes of the safety school and all raw data will be retained by the Operations Research, Human Factors Laboratory of the U.S. Naval Postgraduate School. A fourth safety school class has already been polled, but too late for the data to

be included in this study.

B. ANALYSIS OF DATA

An item hereinafter is defined to mean a single gripe or writeup on a questionnaire. A deficiency is an aircraft problem, i.e., a single deficiency may be referenced by more than one item. It was anticipated that the major analysis would be directed into the following two items.

1. Classification by Aircraft Type

All items were collected and displayed by aircraft type, i.e., A-4, F-14, etc.

2. Major Deficiency Categories

Primary thrust of the study was to determine if there was a commonality of deficiencies among aircraft and across communities. Using the deficiencies in individual aircraft as a basis, it was desired to determine a major deficiency categories which would include as many of the individual deficiencies as possible.

IV. RESULTS

The response from the first three safety school classes was enthusiastic and produced 213 items from 94 respondents. The raw questionnaire information was divided and displayed by type of aircraft. Items were reported on 21 aircraft in the final analysis. This is an excellent indication of the breadth of experience of the safety school students and certainly gave the wide aircraft and community sample that was desired. Table II shows the data broken down by type of aircraft, the respondent status (aviator or NFO) with the number of total items presented by both type of aircrewman and gives an indication of the respondents experience level. The column labeled "simulator" shows the total number of deficiencies that, in the author's opinion, a full scale simulator study by human factors engineers would have discovered.

As expected, this effort resulting in 213 items spread over 21 aircraft left many aircraft with very few items, hence the major analysis effort went into the ten aircraft with the largest data base. These aircraft were the A-4, A-5, A-6, A-7, F-4, F-14, S-2, S-3, P-3 and the E-2. Fortunately this included the newly operational fixed wing aircraft. The fact that an aircraft had few deficiencies and was not listed here is not as might be hoped, because the aircraft was free of deficiencies, but was, rather, because of a lack of respondents in that community. Of the

TABLE II SUBJECT DATA

AIRCRAFT TYPE	# SUBJECTS	PIL NFO	TOTAL ITEMS	PIL NFO	TOTAL FLIGHT HOURS (AVERAGE)	PIL NFO	HOURS LAST 6 MOS. (AVERAGE)	SIMULATION
Attack								
A-4	13	-	31	-	2100 -	190 -	14	
RA-5	3	3	9	7	1280 460	290 115	11	
A-6	7	2	16	3	1605 910	215 95	9	
A-7	6	-	17	-	1825 -	230 -	10	
Fighter								
F-4	7	7	17	16	1500 1250	130 110	9	
F-8	1	-	3	-	1250 -	70 -	3	
F-14	1	2	2	6	2200 2040	60 95	5	
Patrol/ASW/AEW								
S-2	5	-	7	-	3620 -	120 -	2	
S-3	2	-	5	-	3000 -	95 -	3	
P-3	10	-	21	-	2455 -	140 -	10	
E-2	5	2	10	5	1800 1585	55 80	6	
OV-10	1	-	3	-	3000 -	150 -	1	
Trainer								
T-2	3	-	6	-	1300 -	270 -	3	
T-28	1	-	3	-	2700 -	400 -	2	
T-29	1	-	3	-	3100 -	50 -	1	

TABLE II SUBJECT DATA - continued

AIRCRAFT TYPE	# SUBJECTS		TOTAL ITEMS		TOTAL FLIGHT HOURS (AVERAGE)		HOURS LAST 6 MOS. (AVERAGE)		SIMULATION
	PIL	NFO	PIL	NFO	PIL	NFO	PIL	NFO	
Transport									
C-9	1	-	1	-	2000	-	250	-	1
C-130	4	-	6	-	1590	-	205	-	4
Helicopter									
UH-1	2	-	4	-	2950	-	135	-	3
H-3	1	-	5	-	1500	-	45	-	5
H-46	2	-	4	-	1425	-	25	-	2
H-53	1	-	3	-	1400	-	0	-	3
Total	77	16	176	37	2075	1249	150	100	108

ten aircraft with the most data, there were 172 items reported from 75 respondents or 2.29 items per respondent. Of the remaining aircraft there were only 41 items but from only 19 respondents for 2.16 items per respondent. It appears that an aircrewman of any aircraft could, on the average, recall and document 2.27 deficiencies during the test period.

Attempts to analyze Section IV of the questionnaire failed (see Appendix A). The respondents were unable to satisfactorily correlate their items in human factors categories without greatly enlarging the explanatory material. The choice of categories appeared unfortunate in that the categories used were related to categories in MIL-STD 1472B. In the final outcome these categories were not particularly useful. Fortunately, the open ended questions of Section III elicited excellent information which appeared to be complete and unambiguous (see Appendix A). Under these circumstances, Section IV added little information and was considered of little value in the current effort. Section V of Appendix A also did not provide the expected information. Respondent ratings for the same deficiency varied across the whole spectrum of criticality. This aborted the attempt to assign a criticality or importance to a given deficiency. However, this portion of the effort did lead the author to speculate that rather than using a range of criticality for human factors man-machine interface deficiencies, two classes of deficiency could be used. These classes could be directly linked to NATC terminology. They are:

A. URGENT DEFICIENCIES

These are problems which become known to high authority because of an accident/incident or are detected by test and evaluation activities and are recognized as extremely likely to cause an incident/accident. This class of discrepancies is generally remedied on a priority basis often at great cost and sometimes while the whole fleet of aircraft is administratively grounded pending appropriate action.

B. ALL OTHER DEFICIENCIES

These deficiencies are often known, but due to time and money constraints and their apparent unimportance, they remain uncorrected. These are the ones the fleet user "lives with." The great majority of items reported in this study are of this type. Unfortunately, the human element is mixed with these deficiencies and hence the outcome of mixing these deficiencies with the human variability in any given situation may well lead to an accident/incident at some future time. If this occurs, the deficiency may well graduate to the "urgent" category.

Section VI of Appendix A was little used by the respondents and was also considered unnecessary.

In any case, Sections IV, V and VI of the questionnaire were deleted after the second group was polled. This left pages one and two as the currently administered questionnaire.

The deficiencies must be treated with great caution due to the present lack of verification. It remains for a field team with access to the individual aircraft to quantitatively verify these deficiencies prior to final determination. The fact that so many items are reported by so many respondents lends credence to the existence of the problems. Yet substantial field work remains to be done. Verification would apply to such areas as measurement of: cockpit geometry; control forces and displacement and display parameters.

In the final analysis, there were two classifications of deficiency:

1. Single Deficiencies

There will always be a few minor isolated gripes that may never be repeated and possibly are just a function of the individual. As the data base increases, many of these will be duplicated and move into Class B.

2. Repeat Deficiencies

This group of deficiencies consistently reappears among independent respondents. Often the same deficiency occurs in different aircraft and from different communities. This class is considered very significant even though unverified quantitatively by field measurements. The author feels that these deficiencies are extremely real and warrant serious consideration.

Table III shows the frequency distribution of discrepancies. For example, the A-4 aircraft has 31 items reported; 16 were not duplicated. Two deficiencies had two respondents reporting them, one deficiency was reported by four

TABLE III

FREQUENCY OF DEFICIENCIES BY AIRCRAFT TYPE

<u>TYPE AIRCRAFT</u>	<u>TOTAL ITEMS</u>	<u>NO OF DEFICIENCIES WITH FREQUENCY</u>						
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
A-4	31	16	2	0	1	0	0	1
RA-5	16	13	0	1	0	0	0	0
A-6	19	8	3	0	0	1	0	0
A-7	17	15	1	0	0	0	0	0
F-4	33	13	3	2	2	0	0	0
F-8	3	3	0	0	0	0	0	0
F-14	8	6	1	0	0	0	0	0
S-2	7	5	1	0	0	0	0	0
S-3	5	5	0	0	0	0	0	0
P-3	21	13	1	2	0	0	0	0
E-2	15	9	0	0	0	0	0	1
OV-10	3	3	0	0	0	0	0	0
T-2	6	6	0	0	0	0	0	0
T-28	3	3	0	0	0	0	0	0
T-29	3	3	0	0	0	0	0	0
T-39	1	1	0	0	0	0	0	0
C-9	1	1	0	0	0	0	0	0
C-130	6	5	1	0	0	0	0	0
H-1	4	4	0	0	0	0	0	0
H-3	3	5	0	0	0	0	0	0
H-46	4	4	0	0	0	0	0	0
H-53	3	3	0	0	0	0	0	0

respondents and one deficiency had 7 respondents reporting.

The attempt to determine broad problem categories which dominated individual discrepancies led to twelve broad categories. To qualify a category must have deficiencies which were duplicated in a single aircraft and/or which occurred in more than one aircraft. The overall categories into which so many of these deficiencies fit were subjectively derived but are human factors oriented and quickly recognizable by aviation personnel.

Table IV shows the twelve major problem categories which included 111 of the 213 items. That is, 50% of the items could be conglomerated into twelve major categories.

The first column lists the broad deficiency category followed by the type aircraft that had problems in this category. The "components" column is a description in abbreviated aviation terminology of the type of equipment which was involved, if applicable. The final column lists the total items cited in that deficiency category by type aircraft. These are the major problems which irritate or annoy pilots and at worst, cause the lack of efficiency or inability to perform which may result in accidents. Most of these items are self-explanatory and will be easily recognized by an aviator. Almost all of these items are susceptible to being detected by a good cockpit simulator. Item 12 is not really within the scope of the man-machine problem; it is just presented as a potentially interesting sidelight on the attitude of the NFO'S.

TABLE IV

DEFICIENCIES THAT OCCUR IN MORE THAN ONE AIRCRAFT

<u>DEFICIENCY</u>	<u>TYPE AIRCRAFT</u>	<u>COMPONENTS</u>	<u>NO OF ITEMS CITING</u>
1. No approach plate holder	P-3 C-130		3 1
		Total times cited..	4
2. Operating control or looking at displays requires motion conducive to producing vertigo	A-4 RA-5 F-4 F-8 S-2 S-3 T-28 H-1 H-3	radio, tacan, lights nav aids, compass stby gyro, IFF IFF nav gear flap handle UHF mag comp IFF	8 1 2 1 1 1 1 1 1
		Total times cited..	17
3. Control awkward or impossible to reach while strapped in or too difficult to operate	A-4 RA-5 A-6 C-130 H-3 H-3 H-53	weap arm switches throttle (in AB) RAT handle parking brake	1 1 1 1 1 1
		Total times cited..	6
4. Controls or displays obscured or hidden by yoke, stick, or glareshield, etc.	A-4 F-4 F-14 S-2 S-3 OV-10 T-29 C-130 H-3	AOA and landing check list canopy emerg. handle aux. brake peanut gyro gyro horizon turn and bank	8 1 1 1 1 1 1 1 1
		Total times cited..	16

TABLE IV - continued

<u>DEFICIENCY</u>	<u>TYPE AIRCRAFT</u>	<u>COMPONENTS</u>	<u>NO. OF ITEMS CITING</u>
5. Required to continuously hold switch while checking fuel quantities.	A-4 RA-5		1 1 <u>2</u>
		Total times cited..	2
6. Switches or controls nested, similar in type, shape or method of operation. Possible inadvertant actuation and/or actuation of wrong control.	A-4 A-6 A-7 F-4 F-8 F-14 P-3	spoiler arm/dearm, nose wheel steer hook handle/canopy jett cabin press switch/fuel master, flap handle canopy actuator/engine/SPC canopy jett/RAT, IFR, probe AWG-9 fuel shutoff/fule crossfeed Total times cited..	1 1 1 3 2 2 1 2 <u>13</u>
7. Lighting poor	A-4 RA-5 A-7 S-2 S-3 E-2 C-130 H-46 H-53	generally generally IFF panel warning lights generally too bright generally red lights master caution att gyro Total times cited..	1 1 1 1 1 1 1 1 1 <u>9</u>
8. Instrument positioning wrong for good scan	A-4 RA-5 A-6 A-7 E-2	RMI stby comp, viewfinder AOA, VSI stby gyro ACLS Total times cited..	2 2 1 1 2 <u>8</u>
9. Circuit breakers unreachable, unreadable or difficult to pull.	RA-5 A-6 F-4 P-3		1 1 1 4 <u>1</u>

TABLE IV - continued

<u>DEFICIENCY</u>	<u>TYPE OF AIRCRAFT</u>	<u>COMPONENTS</u>	<u>NO. OF ITEMS CITING</u>
10. Seat positioning causes visibility, head rest or ejection curtain handle problems	RA-5 A-6 F-4 P-3 T-2 H-53	switches unreachable ejection handle ejection handle too high headrest too high inst panel too far away Total times cited.	2 5 1 1 1 1 11
11. Non-critical warning lights distracting under certain critical conditions of flight	RA-5 A-7 F-4 S-2 E-2 H-1	O ₂ system LAWS IFF system ACLS LAWS Total times cited.	1 1 1 1 1 6
12. Internal lighting reflects excessively on canopy	A-6 A-7 F-4	VDI radarscope on gun sight Total times cited.	4 1 6
13. Rear cockpit does not have sufficient instrumentation	F-4 F-14	fuel gauge cab press, fuel Total times cited.	4 2 6
TOTAL			111

V. CONCLUSIONS

The author concluded that:

1. Aviators do feel that there are substantial numbers of man-machine interface problems in naval aircraft cockpits.
2. Aviators can articulate and document these problems quite well.
3. The Navy does not sufficiently utilize the assets of the fleet aircrew community data in design study and testing.
4. The continuation of many of these deficiencies (circuit breaker panels, scan patterns, inability to reach or see) from one generation to the next leads to the conclusion that either
 - a. the Navy does not recognize these deficiencies or
 - b. does not consider them important or
 - c. has not devised a suitable method of systematically ensuring that new cockpits do not repeat the same deficiencies of the older aircraft.
5. Two alternatives to improvement of naval aircraft cockpits might be considered:
 - a. continue to allow the industrial contractor to design cockpits. If this alternative is chosen the following areas need attention:
 1. There must be a significant and continuing amplification, clarification and quantification of existing standards and specifications.

2. A realistic, enforceable system must be implemented to prevent violating, omitting or otherwise disregarding specifications and standards.
- b. The Navy must get more involved with its own human factors personnel in research and design in an effort not only to help in advancing the state of the art, but to gain greater control over its own weapon system designs.

VI. RECOMMENDATIONS

It is recommended that:

The Navy consider devoting more resources to the in-house human factors oriented effort to substantially improve the aircrew subsystem by improving design of man-machine interfaces.

Further recommendations are as follows:

1. Study cockpit deficiencies exhaustively and quantitatively to determine if these deficiencies are due to violations or lack of specifications and standards.
2. A Navy developed aircrew station specification should be developed specifically for each aircraft proposed.
3. The long range solution is to improve the aircrew subsystem by initiating a Crewstation Research Center similar to the NASA AMES, cockpit simulator at NAS Moffett Field, California. The proposed simulator need not be overly extensive in its motion capabilities, but should be such that computer support and man-machine system performance data recording capabilities are available. It should have a strong human factors staff and easy access to large numbers of fleet aircrewmembers for use as test subjects. Ideally this simulator would be capable of essentially complete duplication of any existing or potential cockpit. Specifically, dimensions, panels, instrumentation, lighting and seat configurations must be capable of being easily changed, removed or modified.

4. If the above cockpit research center were put in operation, the final result might possibly be a standardized cockpit of optimal dimensions, instrument panels, consoles and equipment based on ongoing and continual research and testing of fleet pilots. Such a cockpit should be quite susceptible to very stringent specifications and standards and could form the basis for a Navy furnished crewstation specification to the airframe contractor.

APPENDIX A

COCKPIT HUMAN FACTORS DEFICIENCY QUESTIONNAIRE

SECTION I - RESPONDENT DATA

Date

Pilot NFO (check one)

Total Flight time

Aircraft flown most in last 6 months. Type Hours

Do you think the data we are trying to get is available elsewhere? Yes No
If yes, where? _____

SECTION II - IDENTIFICATION OR DESCRIPTION OF DEFICIENCY				
	SAMPLE	ITEM 1	ITEM 2	ITEM 3
Type(s) of aircraft involved				
Name of deficient item				
Component ID (if known)				
Manufacturer (if known)				
Was this item/situation standard? Yes No i.e. Did it occur on all aircraft in type?				
If NO, describe below				

SECTION III - BRIEFLY DESCRIBE THE SITUATION AND ITS POTENTIAL EFFECTS

Item 1

Item 2

Item 3

SECTION IV - PROBLEM CATEGORY

Design criteria are well established in MIL-STANDARD 1472B so we expect any problems to be related to the following areas. Please check the area that is applicable. If more than one category is applicable, mark in order of importance by 1, 2, 3, etc.

	SAMPLE	ITEM 1	ITEM 2	ITEM 3
VISUAL DISPLAY relating to seeing, light, dark scan problems, range of view vibration, etc.				
AUDIO DISPLAY relating to hearing, background noise, discrimination, tone, frequency, etc.				
CONTROL: Stick, throttle, knob, switch, actuator				
LABELLING: Unclear, misplaced, size, color, etc.				
WORKSPACE: Size, shape, access, position, etc.				
ENVIRONMENT: Heat, light humidity, noise, etc.				
DESIGN FOR MAINTAINABILITY: If required, can it be fixed. Fuses, light, modules, etc.				
HAZARDS AND SAFETY: Sharp edges, shock, guards				

SECTION V - POTENTIAL EFFECTS

On a scale of 1 to 5 (1=minor, 5- Very serious)

What are the potential effects of this problem under the following conditions?

1. Normal Operations
2. Worst case (i.e. What is the worst you ever saw or heard of happening?
More than one may be marked.

	SAMPLE		ITEM 1		ITEM 2		ITEM 3	
	1	2	1	2	1	2	1	2
FATALITY TO PERSONNEL								
INJURY TO PERSONS								
DAMAGE OR DESTRUCTION TO EQUIPMENT								
MISSION ABORT								
MISSION DEROGATION								
IRRITATION OR INCONVENIENCE								

SECTION VI - FINAL COMMENTS

Now that we have asked some leading questions, if you have any further comments to clarify or add to your written description of the problem, please do so.

SAMPLE

ITEM 1

ITEM 2

ITEM 3

APPENDIX B

INSTRUCTIONS FOR FILLING OUT THE COCKPIT HUMAN FACTORS DEFICIENCY QUESTIONNAIRE

There is presently no large data base, from the pilot's point of view, for problems that the pilot faces caused by the cockpit and its equipment. It may be too late or expensive to change the specific items or address specific problems that relate to known deficiencies today. However, the hope is that a data base made up of such problems, statistically relevant and properly presented in the DESIGN stage of tomorrow's cockpits may save us from having these same or similar problems on our next tour.

The number and date are for statistical purposes only and have been filled out by the instructor. Since the questionnaires have been randomly distributed, you may anonymously speak your mind.

Please operate independently, since if all the P-3 drivers come up with the same item it will tell us one thing (which we don't want). If you all come up with a different item, that will tell us something also.

It is anticipated that 95% of the items will be UNCLASS, however, if the item you wish to relate is classified, please so mark your questionnaire and personally let me know so that the special markings and handling may be complied with.

Now specifically, think back on your last flight experiences and remember some cockpit piece of equipment, murphy, or design feature that was a problem (couldn't reach, see, feel, hear, actuate, etc.) Almost any specific item that caused some difficulty, lack of coordination, hazard, noise, temperature, etc. will be helpful. If you have two or three, so much the better. Space is provided for three items.

Everybody got an item? If not, keep thinking back on flights until you get at least one. OK, carry on!

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